Treatment of complicated distal tibial fractures in diabetic patients

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Background
The treatment of fractures of the distal tibia is associated with high complication rates. Diabetes mellitus places patients at an increased risk for complications following distal tibia fractures whether treated conservatively or surgically. However, this risk is specific to patients with comorbidities of diabetes. There has been debate on the ideal method for the treatment of these patients because much of the literature has highlighted the extremes of potentially poor outcomes. Less invasive techniques for realignment of distal tibial fractures and reduction of the articular fragments using an Ilizarov fixator with or without minimal internal fixation have been recommended as reliable and safe methods for the treatment of these patients.

Patients and methods
Between June 2008 and January 2012, 25 patients with type II diabetes mellitus receiving oral and/or insulin for blood sugar control, with complicated distal tibia fractures, were treated using an Ilizarov fixator. All patients presented within 6 months from their primary treatment in other centers. Fifteen patients were treated conservatively in a cast or braces. Ten patients were treated surgically. All patients presented with nonunited fractures and 22 patients had varus malalignment. Ten of the 15 patients who were treated conservatively had deep pressure sores. Assessment of the ankle brachial index and vascular Doppler study were used as noninvasive techniques to verify the vascularity in the affected limb.

Results
In all patients, the fractures healed, with no need for any procedure to enhance healing. All patients were followed up for 12 months after fixator removal. The average time in an external fixator was 18.1 weeks (average12–22 weeks). On the final follow-up, none of the patients had a long-term sequel of infection. Malunion with less than 5° varus occurred in five patients. None of the patients developed Charcot neuroarthropathy or required amputation during the treatment or at the final follow-up. Long-term bracing for up to 6 months after frame removal was required in five patients with varus malalignment and in the patient who had a proximal fracture.

Conclusion
Diabetic patients with recent or complicated distal tibia fractures having one or more diabetic comorbidities, but with good peripheral vascularity and continuous control of blood sugar level, they can be treated using an Ilizarov external fixator with a lower complication rate than open reduction and internal fixation procedures and with results comparable to those of nondiabetic patients.

Keywords:
diabetic, distal tibia fracture, Ilizarov complicated distal tibia fracture

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Introduction

The treatment of fractures of the distal tibia with or without intra-articular involvement is associated with high complication rates and provides a management challenge to orthopedic surgeons [1].

Limited soft tissue, the subcutaneous location, and poor vascularity impose limitations to conventional internal fixation using either minimally invasive or usual open reduction with large exposures [2].

Diabetes mellitus places patients at an increased risk for complications following distal tibia fractures whether treated conservatively or surgically, especially infection, ulceration, malunion, nonunion, Charcot neuroarthropathy, and even amputation. However, this risk is specific to patients with comorbidities of diabetes such as diabetic retinopathy, nephropathy, neuropathy, vascular disease, either peripheral or coronary, major amputation (contralateral below-knee or above-knee amputation), and Charcot neuroarthropathy. There has been debate on the ideal method for the treatment of these patients

because much of the literature has highlighted the extremes of potentially poor outcomes [3–8].

Less invasive techniques for realignment of distal tibial fractures and reduction of the articular fragments using an Ilizarov fixator with or without minimal internal fixation have been recommended as reliable and safe methods for the treatment of these patients. Circular frames with tension wires provide good stabilization, especially in comminuted lesions, with control of the fracture in all planes. The use of olive wires enables the application of multidirectional forces to reduce syndesmotic separations, tibial malleolar fragments, and can even provide horizontal compression to a spiral fracture pattern. Inclusion of the foot in the external fixator and joint spanning through hinges are also possible with these circular external fixator designs [9–13].

The aim of this study is to present the results of treatment of neglected or mismanaged distal tibial fractures in diabetic patients with one or more of the comorbidities of diabetes.

Patients and methods

Between June 2008 and January 2012, 25 patients with type II diabetes mellitus receiving oral and/or insulin for blood sugar control, with complicated distal tibia fractures, were treated using an Ilizarov fixator. All patients presented within 6 months from their primary treatment in other centers. Fifteen patients were treated conservatively in a cast or braces. Eight patients received open reduction and fixation of the fibula alone, six with plate and screws and two with intramedullary wires. Two patients received open reduction and internal fixation of the distal tibia and fibula. All patients presented with nonunited fractures and 22 patients had varus malalignment. Ten of the 15 patients who were treated conservatively had deep pressure sores (Fig. 1).

Figure 1

Deep pressure sore at the anterior medial aspect of the distal tibia in a patient treated conservatively in a brace.

Implant failure occurred in six patients with plate fibula fixation, with resultant varus deformity (Fig. 2).

The two patients who received open reduction and internal fixation of the distal tibia developed wound infection and the plate was exposed. Fifteen patients were men and 10 were women, with an average age of 57.3 years (range 46–70 years). Patients included in this study had one or more of the comorbidities associated with diabetes (Table 1). Assessment of the ankle brachial index was used as a noninvasive technique to verify the vascularity in the affected limb; patients with ankle brachial index 0.4 or less were excluded from this study. Patients with ankle brachial between 0.8 and 0.5 underwent an arterial Doppler study and vascular surgery consultation to ensure adequate vascularity required for a safe surgical intervention and healing process.

Management of these patients was initiated after their blood sugar was under control using oral hypoglycemic medications and/or insulin, and control of their renal functions, retinal problems, and cardiac conditions.

All patients were treated using an Ilizarov external fixator. Implant removal and wound debridement were performed in patients who had been treated by open

Figure 2

Broken plate fibula with varus malalignment and nonunited fracture distal tibia and fibula.

Table 1 Patients' data at presentation

Patients	Sex	Age	Comorbidity	Method of primary treatment	Complication present at presentation
1	M	52	Neuropathy, vascular (coronary), nephropathy	Conservative	Nonunion, malalignment, infected sore
2	M	58	Neuropathy, contralateral Charcot, vascular (coronary), retinopathy, nephropathy	Conservative	Nonunion, malalignment, infected sore
3	M	55	Vascular (coronary)	ORIF for the distal tibia and fibula	Nonunion, infection
4	F	65	Neuropathy, vascular (coronary)	Conservative	Nonunion, malalignment
5	M	60	Neuropathy, vascular (coronary)	Fixation of the fibula with IM wire	Nonunion
6	F	62	Neuropathy, contralateral Charcot, vascular (coronary), retinopathy, nephropathy	Conservative	Nonunion, malalignment, infected sore
7	F	48	Vascular (coronary)	ORIF for the distal tibia and fibula	Nonunion, infection
8	M	55	Neuropathy, vascular (coronary)	Conservative	Nonunion, malalignment
9	F	46	Neuropathy	Conservative	Nonunion, malalignment
10	M	50	Neuropathy, vascular (coronary), nephropathy	Conservative	Nonunion, malalignment, infected sore
11	M	58	Vascular (coronary), nephropathy	ORIF of the fibula alone with plate and screws	Nonunion, implant failure, varus malalignment
12	M	47	Neuropathy	Fixation of the fibula with IM wire	Nonunion, varus malalignment
13	F	63	Vascular (coronary), retinopathy, nephropathy	Conservative	Nonunion, malalignment, infected sore
14	F	56	Vascular (coronary), retinopathy	ORIF of the fibula alone with plate and screws	Nonunion, implant failure, varus malalignment
15	M	54	Neuropathy, contralateral Charcot, vascular (coronary), retinopathy, nephropathy	Conservative	Nonunion, malalignment, infected sore
16	M	48	Vascular (coronary)	ORIF of the fibula alone with plate and screws	Nonunion, implant failure, varus malalignment
17	M	51	Neuropathy, vascular (coronary)	ORIF of the fibula alone with plate and screws	Nonunion, implant failure, varus malalignment
18	M	64	Neuropathy, vascular (coronary)	Conservative	Nonunion, malalignment, infected sore
19	F	47	Neuropathy	ORIF of the fibula alone with plate and screws	Nonunion, implant failure, varus malalignment
20	F	68	Vascular (coronary)	ORIF of the fibula alone with plate and screws	Nonunion, implant failure, varus malalignment
21	M	65	Neuropathy, vascular (coronary)	Conservative	Nonunion, malalignment
22	F	70	Neuropathy, contralateral amputation, vascular (coronary), retinopathy, nephropathy	Conservative	Nonunion, malalignment, infected sore
23	M	63	Neuropathy, vascular (coronary)	Conservative	Nonunion, malalignment
24	M	62	Neuropathy, contralateral Charcot, vascular (coronary), retinopathy, nephropathy	Conservative	Nonunion, malalignment, infected sore
25	F	67	Neuropathy, vascular (coronary), retinopathy, nephropathy	Conservative	Nonunion, malalignment, infected sore

IM, intra-medullary; ORIF, open reduction and internal fixation.

reduction and internal fixation of the fibula alone and those treated by open reduction and internal fixation of the distal tibia and fibula, and the Ilizarov fixator was applied in the same session. All wounds were closed primarily with no need for plastic coverage. Patients with deep pressure sores received debridement and Z plasty for excision of the wound and fracture end debridement (Fig. 3).

A preconstructed Ilizarov frame consisting of three rings was applied to all patients using tensioned 1.8 wires and 6-mm predrilled conical half-pins. Tensioned 1.8 olive wires were used to stabilize the distal segment.

In nine patients with previous intra-articular extension of the fracture and with a short osteoporotic distal segment of the tibia (distal 4–6 cm), the Ilizarov frame was extended to the foot with a half-ring on the calcaneus and another one on the forefoot.

The deformity in 22 patients with preoperative bone malalignment was corrected gradually. A hinge was placed exactly at the apex of the deformity (center of rotation and angulation) to allow all elements of the deformity to be corrected (Fig. 4). Distraction through a motor rod placed perpendicular to the plane of deformity was started second day postoperatively at a rate of 0.25 mm distraction, four times a day, until full correction of the deformity was achieved, and then hinges were replaced by connecting rods until full healing had occurred. Three patients with good preoperative alignment underwent fracture compression during the surgery.

Postoperative meticulous pin site care with appropriate antiseptic agents was carried out twice daily. Blood sugar control was continued together with control of the patient's general condition. Early mobilization was encouraged in patients with the aid of a walker non-weight-bearing on the affected side. One patient who had undergone contralateral amputation below the knee could only stand with his prosthetic limb, and could not progress with walking until he was allowed to bear weight on the operated side. Ankle movement was encouraged in the 16 patients with ankle-spared frames.

In nine patients with an ankle spanning fixator, the foot rings were removed 12 weeks postoperatively and they were encouraged to start ankle range of motion exercises.

Figure 3

Z plasty for deep sore excision and fracture end debridement.

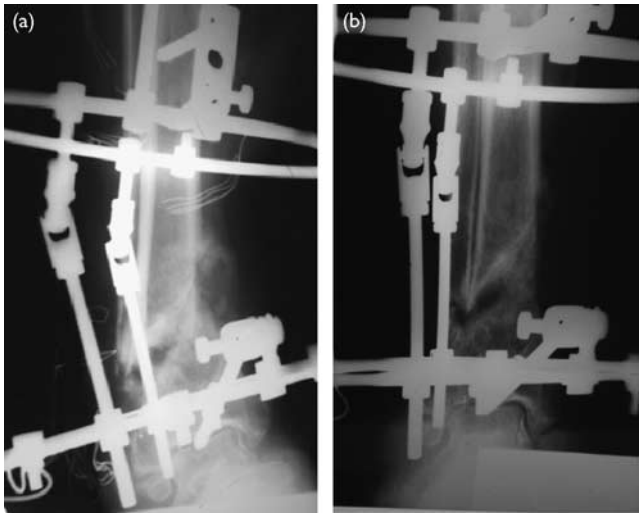
All patients were not allowed weight bearing before bridging callus was observed on follow-up anteroposterior and lateral radiographs that were taken regularly every 2 weeks.

Frames were dynamized for 2 weeks before removal. Then, radiographs were performed before removal to ensure healing and that there was no change in position compared with predynamization radiographs.

Pain on weight bearing or tenderness by palpation after dynamization of the frame were not reliable signs of healing in these diabetic patients as 18 patients had preoperative neuropathy.

Patients were followed up in the outpatient clinic weekly for the first 6 weeks, then biweekly until full healing and frame removal, and then every month for 12 months after frame removal.

Figure 4



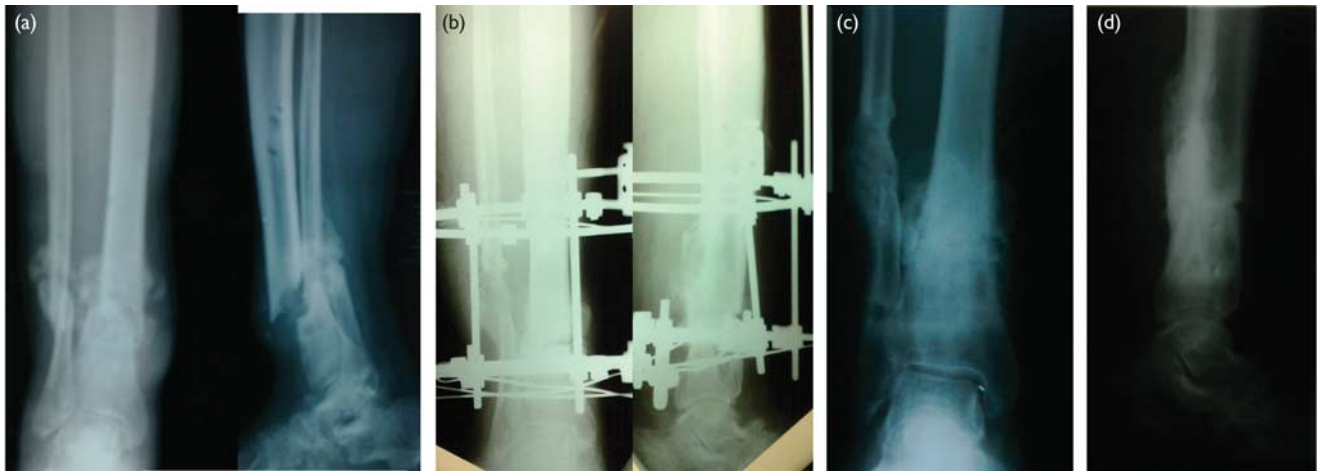
(a) Hinges placed at the center of rotation and angulation to correct varus and translation. (b) Full correction of the deformity achieved.

Results

In all patients, the fractures healed with no need for any procedure to enhance healing (Fig. 5). All patients were followed up for 12 months after fixator removal. The average time in an external fixator was 18.1 weeks (range 12–22 weeks). All patients tolerated the frame well and no premature fixator removal was required.

All patients developed at least one incidence of pin site infection that was controlled by oral antibiotics. In two patients, wires had to be changed and pin site debridement was required because of infection with intravenous antibiotics for 2 weeks. One patient had a fracture proximal to the original nonunion site 4 weeks after frame removal with no definite trauma, and it was found to be related to the previous wire site on review of her radiographs. She refused to undergo another surgery; she was treated in a long leg brace, and healing was achieved after 4 months with 15° of varus (Fig. 6). The arc of ankle range of motion was reduced 20° compared with the contralateral side in 10 patients. In fourteen

Figure 5



(a) Preoperative anteroposterior and lateral radiographs of a patient treated conservatively for a fracture of the distal tibia and fibula. (b) Radiographs during frame application. (c and d) Final antero-posterior and lateral radiographs after frame removal with good healing and alignment.

Figure 6

(a) Fracture proximal to the original nonunion site. (b) After healing in a brace.

patients, the arc of ankle range of motion was comparable to that of the contralateral side. One patient with contralateral amputation had an ankle range of motion arc of 40°.

The primary outcome complications [3] observed in the treatment of diabetic patients with distal tibia fractures included infection, long-term bracing, malunion, nonunion, Charcot neuroarthropathy, or amputation. On the final follow-up, none of the patients had a long-term sequel of infection. Malunion with less than 5° varus occurred in five patients. None of the patients developed Charcot neuroarthropathy or required amputation during the treatment or at the final follow-up. Long-term bracing for up to 6 months after frame removal was required in five patients with varus malalignment and in the patient who had a proximal fracture.

Discussion

Patients with diabetes mellitus with one or more of the comorbidities of diabetes have higher complication rates following both open and closed management of distal tibial fractures. Diabetic patients with distal tibia fractures without comorbidities can be treated as nondiabetic patients with open reduction and internal fixation using less invasive techniques. Patients with neuropathy or vasculopathy are at an increased risk for both soft-tissue and osseous complications, including infection, delayed union nonunion, Charcot neuroarthropathy, and amputation [14].

Because of the extremes of the potentially poor outcome of surgical treatment of diabetic patients with distal tibial fractures, there is debate on whether to treat these patients conservatively or surgically.

Studies were carried out to compare the outcome of surgical or conservative treatment in these patients compared with nondiabetic patients. McCormack and Leith [6] reported over 30% incidence of postoperative complications in 19 diabetic patients with distal tibia fractures treated by open reduction and internal fixation, compared with no reported complications in nondiabetic patients. In addition, the majority of their nonoperatively treated diabetic patients developed malunion.

In another study of 21 operatively treated diabetic patients with ankle fractures, complications occurred in over 40% of the diabetic patients compared with 15% of nondiabetic patients [4].

In a third study of 25 diabetic patients who were treated either operatively or nonoperatively for distal tibia fractures, only the risk of infection was evaluated. Infection complicated treatment for 32% of patients with diabetes compared with 8% of nondiabetic patients. It was also reported that underlying peripheral vascular disease or neuropathy statistically increased the likelihood of infection [15].

The high incidence of complications reported in the literature after operative treatment of diabetic patients especially in the presence of comorbidities has led some orthopedic surgeons to undertreat these patients either conservatively in a brace or by fixing the fibula alone and bracing the leg. In this study, 15 patients were treated conservatively; 10 of these patients had deep infected sores after being treated conservatively in braces and eight patients were treated with internal fixation of the fibula alone with resultant nonunion and malalignment. The two patients treated with open reduction and fixation of the tibia and fibula developed infection and nonunion of their fractures.

For these diabetic patients, careful soft-tissue management and stable fixation are crucial to achieve a good outcome. The use of an Ilizarov external fixator minimizes the risk of soft-tissue complications, bone nonunion, and malunion; a significant decrease in the rate of complications has been found compared with patients treated with plates [13,16,17].

A widely used parameter to anticipate vascularity of the limb is the ankle brachial index, which is the ratio of the systolic pressure at the dorsalis pedis or the posterior tibial artery divided by the systolic pressure at the brachial artery. The normal index is 1–1.4. Patients with an index of 0.5–0.8 have mild to moderate ischemic changes, whereas those with an index of 0.4 or less have critical limb ischemia [18].

In this study, patients with an index of 0.4 or less were excluded and in those with an index between 0.8 and 0.5, further study using arterial Doppler was carried out to measure the pulse volume waveform. Patients with a triphasic or a biphasic waveform were included in the study and those with a monophasic waveform were excluded. The exclusion of the vascular risk limb was because of low healing potentials.

The use of these parameters of good vascularity and the continuous control and close monitoring of blood sugar level during the treatment period might be the main reasons why there was no deep infection or long-term sequel of pin site infection in these high-risk diabetic

patients. Also, all fractures healed without the need for bone grafting. Bone healing with good alignment in 20 patients and less than 5° of varus in five patients is an advantage of the use of the Ilizarov external fixator, which allows continuous postoperative correction until normal alignment is achieved.

Non-weight-bearing after fracture fixation with an Ilizarov fixator until full healing and subsequently protected weight-bearing for a limited time (4–6 weeks) after frame removal are recommended in the management of ankle fractures in patients with diabetes.

Conclusion

Diabetic patients with recent or complicated distal tibia fractures with one or more diabetic comorbidities but with good peripheral vascularity and continuous control of blood sugar level can be treated using an Ilizarov external fixator with lower complication rates than open reduction and internal fixation procedures and with results comparable to those in nondiabetic patients.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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